THE BELL SYSTEM TECHNICAL JOURNAL
Vol. 62, No. 3, March 1983
Printed in U.S.A.

Traffic Service Position System No. 1B:

Long-Range Planning Tools

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(Manuscript received August 9, 1982)

This article describes the issues involved in operator services planning and the structure of the computer tools developed to address these issues. The approach to long-range planning of operator services networks is very flexible, and the availability of the Traffic Service Position System No. 1B further enhances this flexibility. This planning effort is a complex process that has been automated by computer tools that are both accurate and user-friendly.

I. INTRODUCTION

The planning of Traffic Service Position System (TSPS) installations and growth is rather different from that usually encountered in engineering central office equipment.[1] One of the reasons for this is the great flexibility that the engineer has in selecting the placement of operator position subsystems and how traffic will be routed to the various TSPSs that serve a particular area. The availability of the TSPS No. 1B offers new choices: formerly, when a TSPS exhausted its call processing capacity the alternatives were to divert the traffic overload to another TSPS that had surplus capacity or to purchase a new TSPS and divert load to it. Under the new system a TSPS No. 1 can be retrofitted to a TSPS No. 1B with much greater call capacity.[2] The resulting efficiencies, including avoidance of trunk rearrangements, trunk splintering, and opening of new operator groups, provide significant economic benefits to the operating telephone company. The TSPS No. 1B also provides the engineer more opportunities to consolidate, that is, to retrofit a subset of a group of TSPS No. 1's to TSPS No. 1B's and retire some or all of the remaining TSPS No. 1's in the group.

The Operator Services Traffic Network Planning System (OSTNPS) is a tool designed to aid telephone companies in making long-range plans for TSPS and related network evolution in order to guide short-range planning activities.[3] OSTNPS has been available to telephone companies since November 1981. Using interactive programs and a *UNIX** operating system environment, OSTNPS lets the user make the critical decisions while taking over the detailed calculations that can often severely limit the number of alternatives that a planner considers. OSTNPS combines maximum user flexibility with fast turn-around: the user can generate and analyze an alternative satisfying all the necessary constraints in about two hours of terminal time (CPU time is negligible). Since a typical alternative may involve 45 nodes and an associated network configuration over a 20-year period, design considerations and human factors engineering were of the utmost importance in developing OSTNPS.

Many of the factors to be considered existed for the TSPS No. 1 before the development of the TSPS No. 1B; the general approach taken with the program design made addition of the new degree of freedom relatively simple. This article describes the problems involved in planning TSPSs, and the software programs developed to guide the user in this planning.

II. PLANNING ISSUES

2.1 Long-range planning

The purpose of long-range planning is to evaluate the results of the most likely trends in traffic, services, and technology in order to optimize the long-term results of short-range decisions. The usual long-range plan covers a period of 20 years. The procedure consists of generating a set of alternatives and comparing the economic worth of each. The alternatives usually include a continue-as-is base plan with which the other alternatives are compared.

Because 20-year forecasts involve many potential contingencies, the long-range planner must apply judgment and experience to select the most reasonable alternatives and to perform appropriate sensitivity analysis on these alternatives.

2.2 Operator services long-range planning issues

The choices specific to operator services include the following.

2.2.1 Purchase of naw nodes

Usually the purchase of a new TSPS, Remote Trunk Arrangement

* Trademark of Bell Laboratories.

(RTA), or Position Subsystem (PSS) is made to relieve tbe exhausts of existing nodes.[4] The planner must decide where to place the new node and where its traffic is to come from. For example, a new TSPS may be loaded in such a way as to delay its exhaust and that of neighboring systems for as long as possible, or it may be placed in a way such that its resultant traffic is routed over facilities that are as short as possible. Usually a new PSS is placed where there is a large operator labor market. The issues involved in an RTA purchase will be discussed in Section 2.2.4.

2.2.2 Retrofit to TSPS No. 1B

A TSPS No. 1B has greater real-time and memory capabilities than a TSPS No. 1. If the TSPS No. 1 exhausts real time or memory, then the savings in rearrangements and/or new node purchases must be weighed against the costs of retrofit and, in a growth environment, the eventual purchase of a new node.

2.2.3 Load balancing

Load balancing consists of moving trunks, and hence traffic, from one node to another in such a way that all exhausts are relieved. Load balancing eliminates the capital expenditure of a new operator node in the given year, but the purchase is only deferred and load balancing can be quite expensive in itself because of trunk rearrangements.

2.2.4 RTA issues

An RTA concentrates trunks and homes them in on a nearby TSPS via base-remote (BR) trunks.[4] The planning issues specific to RTAs are as follows.

- Direct versus RTA trunking. If a set of local offices is located a long distance (say 100 miles) from tbe TSPS on which the offices are to be homed, one alternative is to trunk tbem directly to the TSPS and another is to concentrate these trunks via an RTA. In the former case, trunk and facility costs dominate; in the latter, purchase of an RTA is necessary. In general, purchasing an RTA is desirable if many trunks are involved and the distance to the TSPS is large.
- Colocated RTA. If a TSPS reaches a condition of trunk exhaust, an RTA may be purchased and colocated with the TSPS: the RTA concentrates some of the TSPS incoming trunk calls and relieves the exhaust. Further, a colocated RTA-TSPS pair gives more flexibility in load balancing if the TSPS later becomes exhausted for any other reason: the RTA could then be rebomed on a nearby TSPS with spare capacity. An RTA rebome is defined as a move of its base-remote trunks; if tbe RTA were not there, a

move of about eight times as many TSPS incoming trunks would be necessary.

2.2.5 PSS rehoming

TSPS operators are assigned to PSSs, consisting of groups of operator consoles and the associated intelligence.[4] A move involving TSPS/RTA traffic usually means that position requirements at that TSPS will change. If a sufficient amount of traffic is moved from one TSPS to another, one or more PSSs may be rehomed between these TSPSs. The planner generally has great flexibility in these rehomings except for mileage constraints.

2.2.6 Impact on toll trunking

Sometimes a move of TSPS/RTA traffic impacts on toll trunking as well. Since TSPS and RTA incoming trunks are bridged between the local office and toll switch, a move of these trunks implies a corresponding connect/disconnect of trunks at the associated toll switches. Moreover, such a move will also cause a change in intertoll trunking. Every local area generates operator traffic that returns to itself via the toll switch. When TSPS/RTA incoming trunks are moved from one toll switch to another, the traffic must have a path from the second toll switch back to the first via Direct Distance Dialing (DDD) trunks. This path would not have been necessary had the move not taken place. On the other hand, an RTA rehome does not change toll trunking since only BR trunks are involved. Detailed examples of these issues will be considered in Section IV.

2.3 New considerations with TSPS No. 1B

A TSPS No. 1 that exhausts real time or memory can be relieved by retrofitting a 3B20D Processor in place of the present Stored Program Control No. 1A—a procedure that converts TSPS No. 1 to TSPS No. 1B.[2] The demand for the 3B20D Processor for TSPSs existed because real time or memory is the limiting factor on most TSPSs today. From a planning point of view, this method of relief is easiest because no traffic rearrangements are needed.

2.3.1 Selective conversion to TSPS No. 1B

Because of capital constraints, a planner may convert some but not all exhausted TSPS No. 1's to TSPS No. 1B in a given year. This strategy introduces new effects on planning: a combination of conversion to TSPS No. 1B, TSPS/RTA purchases, and load balancing may take place. Consider the following example. Suppose that both TSPSs A and B (both TSPS No. 1's) exhaust real time in some study year and that a single conversion to TSPS No. 1B is to be made in that

year. The planner retrofits A, giving it extra real-time capacity. To relieve B, the planner takes the following steps: two RTAs are purchased, colocated with B, loaded with incoming trunks from B, and homed on A. B is thus relieved and survives real-time exhaust two more years, at which time B is retrofit and the RTAs are rehomed back to B.

2.3.2 TSPS consolidation

Planning issues are different in low-growth regions: the added real-time capacity of TSPS No. 1B increases the possibility of TSPS consolidation. First a consolidation candidate must be selected from a group of nearby TSPSs. It may be the oldest, most centrally located, or most lightly loaded TSPS of the group. The TSPS is retired by moving all of its traffic to the other TSPSs in the group. After consolidation, the remaining TSPSs may have to be converted to TSPS No. 1B earlier than if consolidation had not taken place, since they will exhaust sooner.

III. USER-CONTROLLED PLANNING TOOL

3.1 Design considerations

OSTNPS was developed so as to combine extreme flexibility with very fast turnaround. Extreme flexibility means that the user can generate any alternative desired—the programs check that no constraints are violated along the way. Very fast turnaround means that the input database and modeling must be both representative and simple, so that generation and analysis of an alternative can be done in an hour or two. A typical operator services alternative consists of 5 TSPSs, 8 RTAs, 20 PSSs, and a dozen toll switches all evolving as a function of time with consolidation, purchase of new nodes, or load balancing. The usual study period is 20 years so that, with a base year, there may be up to 21 toll-connect and intertoll sets of trunk requirements ("trunk fields") associated with the alternative. A typical number of such solutions is ten.

OSTNPS does not optimize but rather lets users generate their own alternatives. For a given study area, it is not known how close a given plan is to the optimum because the optimum is not known to begin with. However, analysis of all possible alternatives for a given simple study area suggests that the economic worth of a typical "intelligent" user plan will be within 5 percent of the optimal plan.

3.2 Modeling considerations

Modeling considerations are as important as design considerations, because inputs must be at once representative and simple if the objective of fast turnaround is to be met.

3.2.1 Input database

For mechanized long-range planning, it is desirable to obtain reasonable results using data that are easy for users to collect. OSTNPS requires comparatively little user input data, and all data come from standard sources. Implied in the small size of the input data base are several assumptions—summarized below—used to make forecasts.

The input database contains only three types of call volumes: total trunk seizures on TSPS (whether or not an operator is accessed), trunk seizures that reach an operator for any purpose, and trunk seizures that reach an operator only for Operator Number Identification (ONI) of the calling party. These three volumes, for every TSPS and study year, are the primary inputs into all of the forecasting algorithms.

Some of the algorithms are linear regressions based on these volumes. One such regression forecasts required operator consoles (positions), tbe independent variable in this case being the product of the number of attempts reaching an operator and tbe average operator work time per call (both input database items). In reality, the relationship is not quite linear because large operator teams are more efficient tban small operator teams. However, this lack of linearity occurs primarily in lightly loaded TSPSs; for moderately to heavily loaded TSPSs, a linear relation is sufficient.

Simplifying assumptions are also made in modeling the required TSPS trunks. First, minor trunk types are considered as a single category, a simplification that cuts down required input data considerably. Second, for each trunk type considered by the program, it is assumed that groups are of equal size, and that each group handles the same number of attempts with tbe same holding time per attempt. The average trunk group size is an input item, and the holding time is derived from input items. These approximations are quite suitable for long-range planning, and because of them, the input database is made far easier for the user to create.

3.2.2 Network

Even though OSTNPS is fundamentally an operator node planner, there must be a way to estimate the cost of trunk movements resulting from shifts in loads. Trunk movements occur in the toll-connect and intertoll fields. In the toll-connect field, it is adequate to assume that when a deload occurs, the appropriate number of trunks are disconnected from the deloaded operator node and the same number reconnected to the other (if the two operator nodes are colocated, the costs are different tban if they are not, and this is properly taken into account). This information, together with percentages of 2-wire and 4-wire bridges, facilities, and average mileages between the local offices and toll switches before and after, is sufficient to get a good estimate

of the toll-connect movement costs. Intertoll movement also occurs after a deload since the load on all toll switches is affected, depending on community of interest. It would be unnecessarily complex to reengineer the toll network after each deload or purchase. Instead, the change in offered load between every pair of toll switches is estimated and converted to trunks. Because intertoll trunk groups are generally larger and thus more efficient than toll-connect trunk groups, it is assumed that an intertoll trunk carries twice the load as a toll-connect trunk.

IV. STRUCTURE OF PROGRAMS

4.1 Introduction

The joh of generating and evaluating a long-range operator services alternative can he split into four separate tasks, each programmed as a separate OSTNPS module. Figure 1 shows a general flowchart of the process, and Fig. 2 illustrates the scope of each of these programs in the overall operator services network.

(*i*) Node exhaust. The Node Exhaust program calculates requirements for each TSPS/RTA node in each year, informs the user about possible exhausts, and lets the user relieve the exhausts by purchasing new nodes, moving traffic, or converting to TSPS No. 1B. This program does not involve itself with the network connecting the nodes—this task is performed later.

(*ii*) PSS. The PSS program, given overall position requirements from the Node Exhaust program, assigns specific PSSs for these requirements and builds the network joining those PSSs to the TSPSs.

(*iii*) Remainder of network. The Network program assigns specific trunk groups between local areas, TSPS/RTA's, and toll switches. As discussed in Section 4.4, the detailed network can he reconstructed given the global requirements output by the Node Exhaust program for each TSPS/RTA.

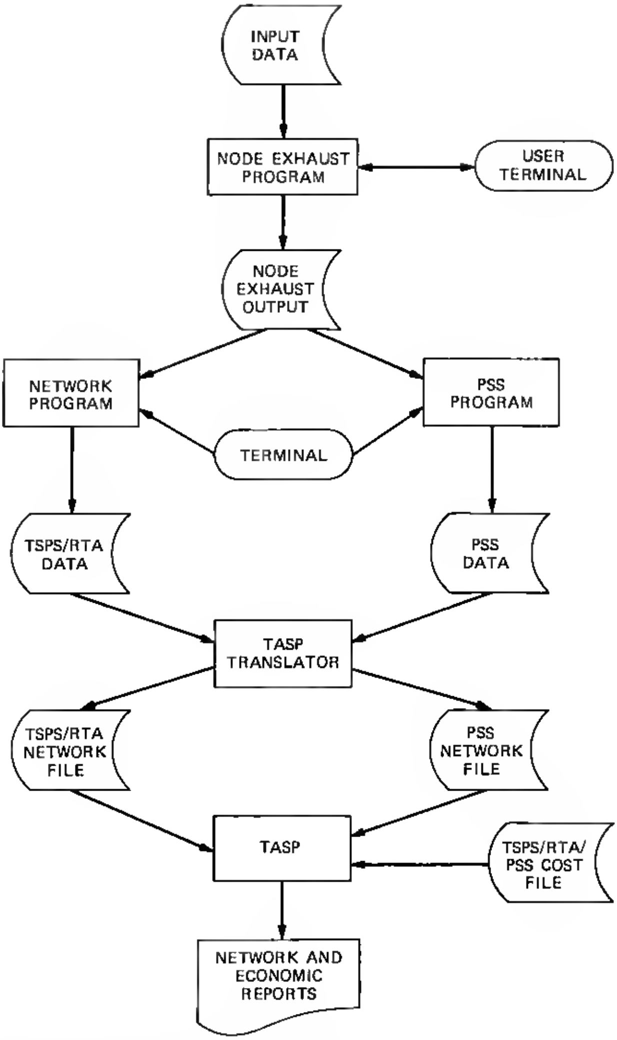
(*iv*) Translation for Economic Analysis. The Translator program combines the output of the preceding two programs and transforms it into a "network file" for the economic evaluator program TASP (Toll Alternatives Studies Program).[5] TASP, a very detailed economic evaluator based on Capital Utilization Criteria (CUCRIT), requires a user-supplied "cost file" as well as the above network file.

Following is a detailed description of each of these programs.

4.2 Node Exhaust program

4.2.1 Summary

The Node Exhaust program is the first module of OSTNPS. Starting with a set of user-supplied input data describing the operator nodes



PSS - POSITION SUBSYSTEM
RTA - REMOTE TRUNK ARRANGEMENT
TASP - TOLL ALTERNATIVES STUDIES PROGRAM
TSPS - TRAFFIC SERVICE POSITION SYSTEM

Fig. 1—Flowchart of OSTNPS.

(TSPSs and RTAs) in the study area, the program generates part of an alternative interactively. The alternative is refined further in succeeding OSTNPS modules. Figure 3 shows a general flowchart of the Node Exhaust program.

For each study year, the program forecasts requirements for relevant TSPS/RTA items and compares these numbers with their respective

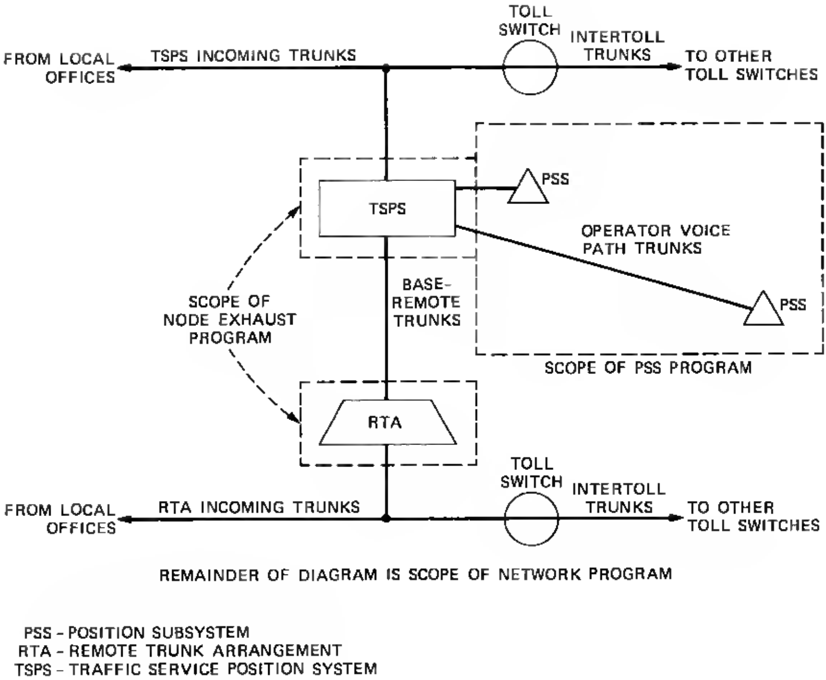


Fig. 2—Scope of OSTNPS program.

capacities. If an exhaust occurs, the program prints out the operator node that is exhausted, along with the cause(s) of exhaust, and a complete status report on all other operator nodes. The user is given an opportunity to purchase new nodes, convert to TSPS No. 1B, or to move traffic from one node to another. The program will proceed to the next study year only if there are no unrelieved exhausts. After completion of the last study year, the alternative is stored in a data base to be used by subsequent modules of OSTNPS.

It should be emphasized that the user interacts with the program on a year-by-year basis while the program is running. It is not necessary for the user to know exactly what traffic moves and node purchases to make before the study begins.

4.2.2 Description of exhaust causes

The Node Exhaust program considers TSPS/RTA exhaust causes of several types. The most common type of exhaust for a TSPS No. 1 is real time; with the development of TSPS No. 1B and its associated increase in real-time capacity, a TSPS may exhaust owing to a number of other causes. Following is a description of other exhaust causes.

4.2.2.1 TLN terminations and individual trunk types. Various types of

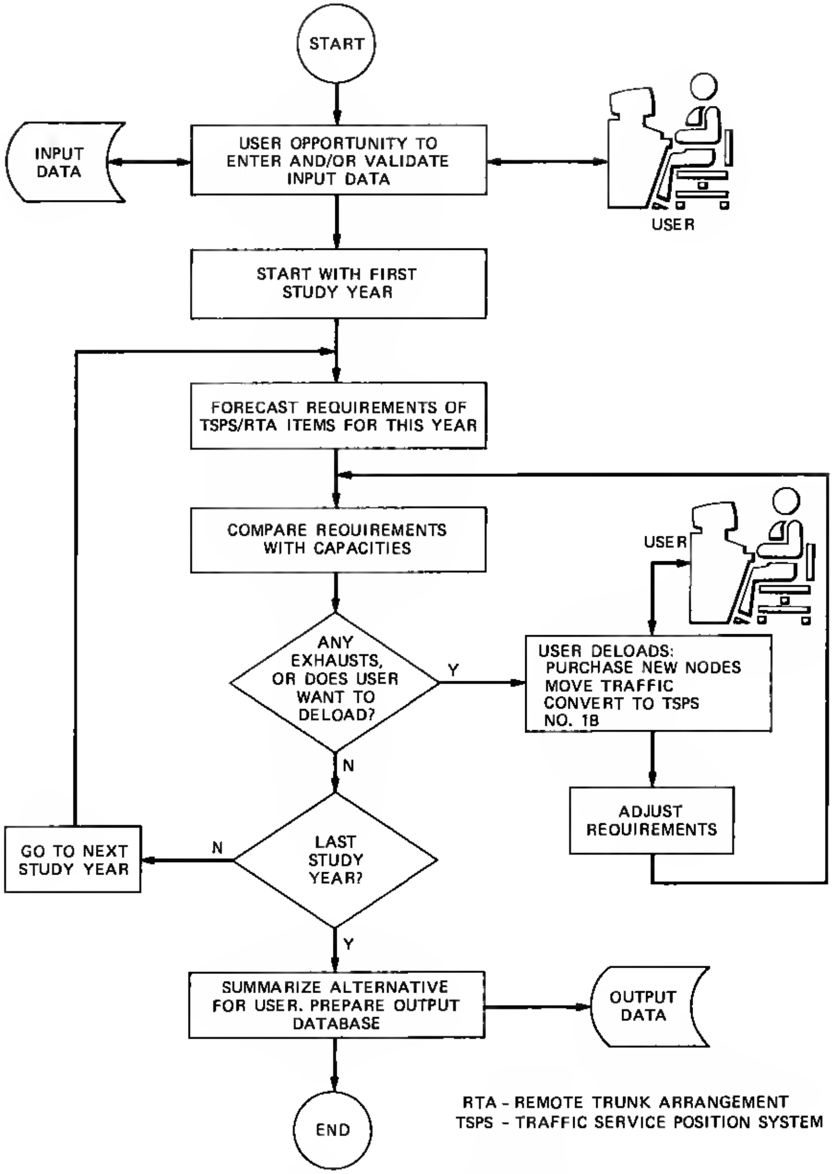


Fig. 3—Flowchart of Node Exhaust program.

TSPS trunks terminate on Universal Trunk Frames (UTFs) which in turn attach to the Trunk Link Networks (TLNs). These trunk types include: incoming ("universal") trunks, Transfer Centralized Automatic Message Accounting (XCAMA) trunks, Base-remote (BR) trunks, and all other TSPS trunks considered as a single category.[6]

A TSPS becomes TLN-exhausted if, after engineering each TLN trunk type and fitting these trunks on UTFs, the required number of UTFs (including an administrative margin) exceeds the hardware limitation. In addition, a TSPS can exhaust if one of the individual trunk types exceeds its software, design, or hardware limitation.

4.2.2.2 PLN appearances and positions. The Position Link Networks (PLNs) contain terminations by which operator positions and various service circuits (receivers, outpulsers, announcement circuits, etc.) connect to the TSPS. As in the TLN case, a TSPS becomes PLN-exhausted if, after engineering positions and service circuits, the total number of PLN appearances exceeds hardware limitations.

4.2.2.3 TSPS network. TSPS traffic travels between trunks requiring service and circuits/operators providing service via the TSPS network. A given trunk can connect to a given position or service circuit via one of eight paths composed of "A," "B," and "C" links. The TSPS network is limiting if its offered Erlang load is sufficiently great to result in a blocking probability greater than 0.001.

4.2.2.4 TSPS offica data mamory. TSPS memory is subdivided into two types: the generic program and office data. Office data memory contains information specific to the design and traffic characteristics of a given TSPS site. Conversion of a TSPS No. 1 to a TSPS No. 1B increases the total amount of addressable memory as well as real time.

4.2.3 Input data

The input data to the Node Exhaust program include, for each TSPS/RTA in the study area, base year requirements for various trunk types as well as current and forecast call volumes of various types.

The following data are required:

- Call volumes: trunk seizures, position seizures, and XCAMA trunk seizures
- Trunks: base and RTA incoming trunks, XCAMA trunks, and all other trunks except BR
- Real-time capacity in trunk seizures
- Operator Average Work Time (AWT).

4.2.4 Forecast of TSPS/RTA items

For a given study year, the Node Exhaust program uses these input data to forecast TSPS/RTA items that determine exhausts. The program uses simple formulas or linear regressions in place of detailed calculations.

Figure 4a shows a sample printout of these items from an actual study. At user request, this printout will appear in any study year while the Node Exhaust program is running.

	TSP1	TSP2	TSP3
BASE INC TSZ	5226	11730	8241
XCAMA TSZ	800	1300	1200
RTA RTA1 - TSZ	2264	0	0
RTA RTA2 - TSZ	1144	0	0
RTA RTA3 - TSZ	1116	0	0
RTA RTA4 - TSZ	1400	0	0
RTA RTA5 - TSZ	0	0	984
RTA RTA6 - TSZ	0	0	1230
RTA RTA7 - TSZ	0	0	1038
RTA RTA8 - TSZ	0	0	1146
TOTAL NON-XC TSZ	11150	11730	12639
TOTAL TSZ	11950	13030	13839
R-T CAPY (TSZ)	16007	16587	17621
REALTIME - % RTC	74	78	78
BASE INC TKS	555	1786	959
XCAMA TKS	24	36	24
RTA RTA1 - INC TKS	283	0	0
RTA RTA2 - INC TKS	143	0	0
RTA RTA3 - INC TKS	186	0	0
RTA RTA4 - INC TKS	280	0	0
RTA RTA5 - INC TKS	0	0	246
RTA RTA6 - INC TKS	0	0	246
RTA RTA7 - INC TKS	0	0	173
RTA RTA8 - INC TKS	0	0	191
OTH BASE TKS, EX BR	73	213	68
TLN - TOTAL UTF	5	8	6
POSITIONS (TRAFFIC)	71	80	53
PLN - TOTAL APPR	276	300	251
NETWORK (ERLANGS)	75	92	105
MEMORY (OFC NMCDS)	4	5	5
POSITION SEIZURES	7205	8082	5552

Fig. 4(a)—Node Exhaust printout before user move—1984.

The following forecasts are made:

- Real-time usage
- Trunks of various types
- Memory
- Operator positions
- Service circuits
- TSPS network load.

4.2.5 Exhaust prediction

Once the above items are forecast in a given study year for every TSPS/RTA in the study, the program compares these numbers with their respective upper limits. The program thus determines for each TSPS/RTA whether it is exhausted and for what reasons.

4.2.6 User-specified changes to network

Input commands to the Node Exhaust program allow the user to purchase new operator nodes or move traffic from one node to another

	TSP1	TSP2	TSP3
BASE INC TSZ	5226	11730	0
XCAMA TSZ	2000	1300	0
RTA RTA1 - TSZ	2264	0	0
RTA RTA2 - TSZ	1144	0	0
RTA RTA3 - TSZ	1116	0	0
RTA RTA4 - TSZ	1400	0	0
RTA RTA5 - TSZ	984	0	0
RTA RTA6 - TSZ	1230	0	0
RTA RTA7 - TSZ	1038	0	0
RTA RTA8 - TSZ	1146	0	0
RTA NEW1 - TSZ	0	2750	0
RTA NEW2 - TSZ	0	2750	0
RTA NEW3 - TSZ	0	2741	0
TOTAL NON-XC TSZ	15548	19971	0
TOTAL TSZ	17548	21271	0
R-T CAPY (TSZ)	26882	26711	0
REALTIME - % RTC	65	79	0
BASE INC TKS	555	1786	0
XCAMA TKS	48	36	0
RTA RTA1 - INC TKS	283	0	0
RTA RTA2 - INC TKS	143	0	0
RTA RTA3 - INC TKS	186	0	0
RTA RTA4 - INC TKS	280	0	0
RTA RTA5 - INC TKS	246	0	0
RTA RTA6 - INC TKS	246	0	0
RTA RTA7 - INC TKS	173	0	0
RTA RTA8 - INC TKS	191	0	0
RTA NEW1 - TNC TKS	0	320	0
RTA NEW2 - INC TKS	0	320	0
RTA NEW3 - INC TKS	0	319	0
OTH BASE TKS, EX BR	97	257	0
TLN - TOTAL UTF	6	10	0
POSITIONS (TRAFFIC)	92	112	0
PLN - TOTAL APPR	349	409	0
NETWORK (ERLANGS)	164	223	0
MEMORY (OFC NMCDS)	5	6	0
POSITION SEIZURES	9920	10919	0

Fig. 4(b)—Node Exhaust printout after user move—1984.

at any time. These steps are mandatory if there is an unrelieved exhaust; otherwise they are optional (as in the case of TSPS consolidation). The possible options are as follows:

- The user may convert a TSPS No. 1 to TSPS No. 1B.
- The user may purchase a new TSPS or RTA.
- The user may move TSPS or RTA incoming trunk seizures from one node to another.
- The user may rehome an RTA from one TSPS to another.
- The user may move XCAMA trunk seizures from one TSPS to another.
- The user may retire a TSPS or RTA.

If exhausts are still not relieved after such a series of steps, the

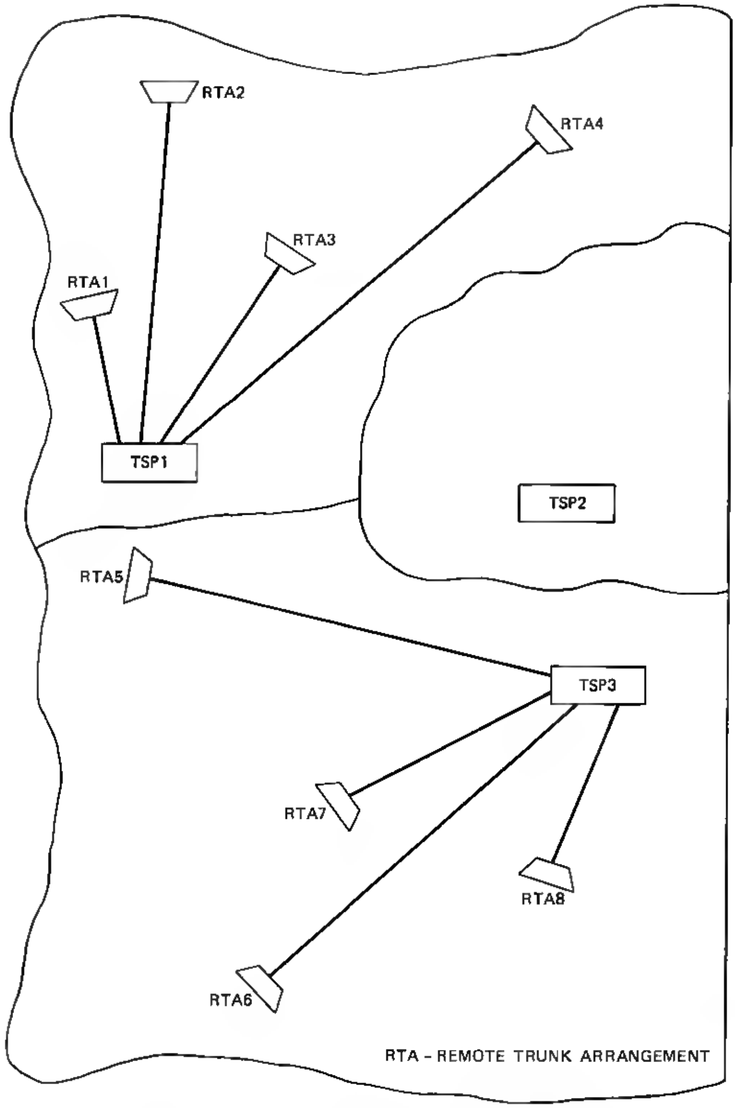


Fig. 5(a)—TSPS/RTA configuration before user move.

program will not proceed to the next study year. The user must start over with the given study year and try another strategy.

4.2.7 Example

Figures 4 and 5 illustrate the results of a set of moves made during a run of the Node Exhaust program. Figure 4 lists the relevant forecasts

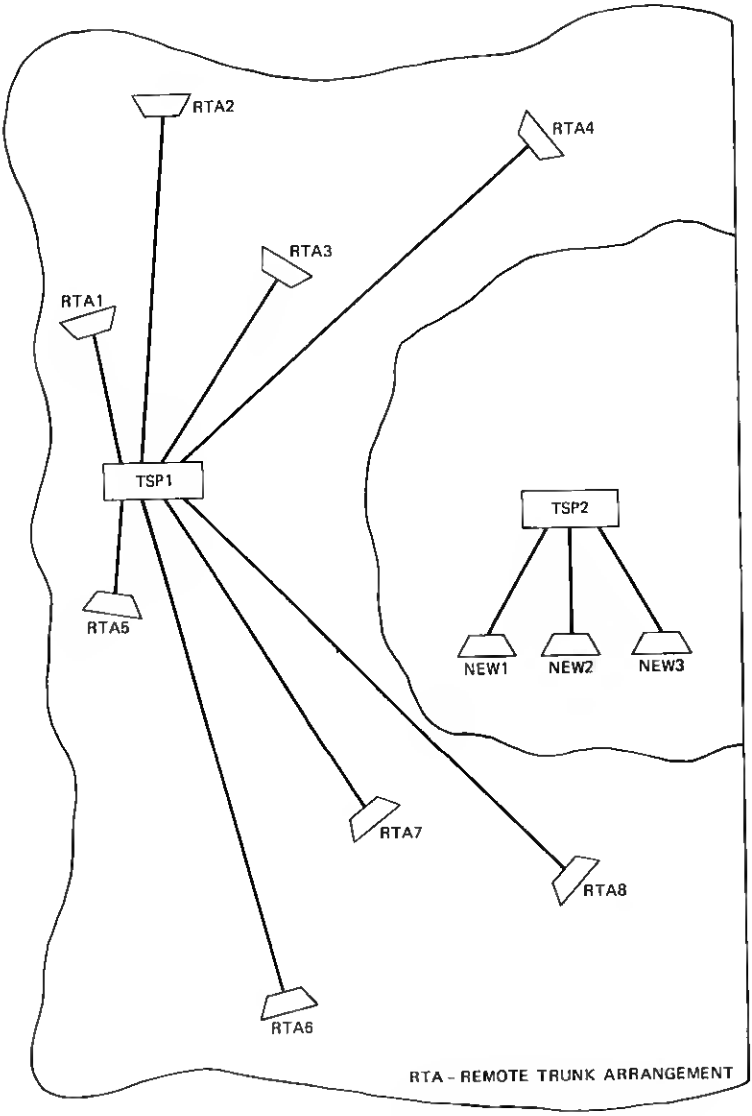


Fig. 5(b)—TSPS/RTA configuration after user move.

before and after the moves, and Fig. 5 shows a pictorial representation of this situation.

The study area consists of three TSPSs: TSP1, TSP2, and TSP3, all of which are TSPS No. 1's. These are the columns in Figures 4a and 4b. Each row represents a given forecast item for the study year, in this case, 1984. The tables are split into two sections: "User-Controlled

Items" (trunk seizures which the user may directly move from one operator node to another) and "Other Relevant Items" (exhaust-determining items which indirectly cbange as a result of such a move).

To evolve from Fig. 4a to 4b, the user retires TSP3 in the following way. First, RTAs RTA5, RTA6, RTA7, and RTA8, presently homed on TSP3, are rehomed to TSP1. Second, RTAs NEW1, NEW2, and NEW3 are purchased, homed on TSP2, and loaded with all of TSP3's base incoming traffic. Finally, all of TSP3's XCAMA traffic is moved to TSP1, leaving TSP3 with no traffic and hence retired. The remaining TSPSs TSP1 and TSP2 exhaust real time as a result of the move, and they are converted to TSPS No 1B's.

4.2.8 Completion of run

Once all years in the study period have been covered, the relevant information for the alternative is printed on the user's terminal. The information is also organized into an output database for use by the PSS and Network programs described below.

4.3 PSS program

4.3.1 Summary

The main function of the PSS program is to establish a schedule for Position Subsystems (PSSs). This task can be separated from all others because its only input is the total required number of operator positions on each TSPS for each study year. Numbers of positions are established in the Node Exhaust program depending on incoming traffic to the TSPSs. Once the schedule is established, an additional task is to obtain facilities between eacb PSS and its home TSPS.

4.3.1.1 PSS schedule. The schedule is determined by the following considerations:

- Total number of positions required on each TSPS in each study year.
- Equipment actually in the field in the base year.
- The absolute and recommended maximum number of positions per PSS.
- The type of PSS (PSS1 or PSS2).*
- Minimization of the number of PSSs in the study, subject to administrative constraints and operator availability.

The solution consists in presenting to the user a schedule that is compatible with all the constraints, as in Fig. 6a, and letting the user modify it as desired by means of interactive commands, as in Fig. 6b.

Following is a description of Fig. 6a. First, equipment in the field

* PSS1 positions are no longer being manufactured, and PSS1s remain capped at their present position levels.

	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	0
TSPS1																					
PS11*	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55
PS12	30	18	23	27	33	34	36	38	40	42	45	48	50	50	28	30	33	35	38	40	43
PS13	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
TSPS2																					
PS21*	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55
PS22*	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
PS23	30	0	0	0	14	14	17	20	23	25	28	32	35	39	0	0	0	0	0	0	0
TSPS3																					
PS31*	55	55	55	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PS32*	28	28	28	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PS33	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TSPS4																					
PS41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	50	50	50	50	50	50
PS42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	29	32	34	37	40	43

Fig. 6(a)—A first-order PSS field.

	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	0
TSPS1																					
PS11*	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55
PS12	30	18	23	27	30	30	30	30	30	30	30	30	30	30	28	30	33	35	38	40	43
PS13	0	0	0	0	3	4	6	8	10	12	15	18	20	23	0	0	0	0	0	0	0
TSPS2																					
PS21*	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55
PS22*	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
PS23	30	0	0	0	14	14	17	20	23	25	28	32	35	39	0	0	0	0	0	0	0
TSPS3																					
PS31*	55	55	55	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PS32*	28	28	28	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PS33	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TSPS4																					
PS41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	50	50	50	50	50	50
PS42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	29	32	34	37	40	43

Fig. 6(b)—PSS field after the first move.

(base year) is entered by the user (1980 in this case). PSS1's, for which positions are capped, are marked with a "*". For the study years (1981–2000), the scheduler bases its calculations on position requirements and purchases new PSSs where needed.

Given this PSS schedule, the user can modify it with the following interactive commands:

- For a given TSPS, the user may redistribute the number of PSS2 positions.
- The user may rehome a PSS2 from one TSPS to another.

- The user may or may not release unneeded PSS2 positions for reuse.

Consider Fig. 6b. The first move consists in all excess positions beyond 30 in the base year being moved from PS12 to PS13 for all study years up to 1994. A possible second move consists of making PS33, PS13, and PS42 the same PSS by rehoming PS33 (originally homed on TSPS3) to TSPS1 in 1984, then to TSPS4 in 1994.

4.3.1.2 PSS facilities. Once the schedule is established, the program asks the user for facility data between TSPSs and the PSSs. This, together with the schedule, completely determines the input to the economic analysis program.

4.4 TSPS/RTA Network program

Besides the network joining TSPSs to PSSs, there is the network joining local offices and toll switches to TSPS/RTA's. This network can be divided into three distinct portions:

- Toll connect trunks (local office to TSPS/RTA to toll switch).
- Base remote trunks (RTA to TSPS).
- Intertoll trunks.

Figure 7b shows an example of such a network.

The Node Exhaust program allocated total trunk seizures amongst the TSPS/RTA's without making any assumptions about the network. The separation of exhaust planning and network planning allows simplified program design, and allows the user to concentrate on each issue separately. The method used to model the network allows this separation to work; the network program guides the user through the steps of establishing the network corresponding to the alternative formulated by the Node-Exhaust program.

At the beginning of the study, there is by definition a one-to-one correspondence between "local areas" and TSPS/RTAs (Fig. 7a). User-specified traffic moves made during a node exhaust run may affect the network in the following ways (see Fig. 7b):

- A move of base-remote trunks, also called an RTA rehome (a) in Fig. 7b.
- A move of toll-connect trunks (b) in Fig. 7b.
- Cbanges in the intertoll network. A certain percentage of operator traffic leaving a local area must go back to the same local area via its toll switch. Corresponding to each toll-connect move (b) is an increase in required intertoll trunks (b′). No such intertoll adjustment is necessary for a base-remote move.

The Network program obtains the following information from the user:

- Toll switch information: names, types, homing TSPS/RTAs.
- Base-remote mileage and facility information.

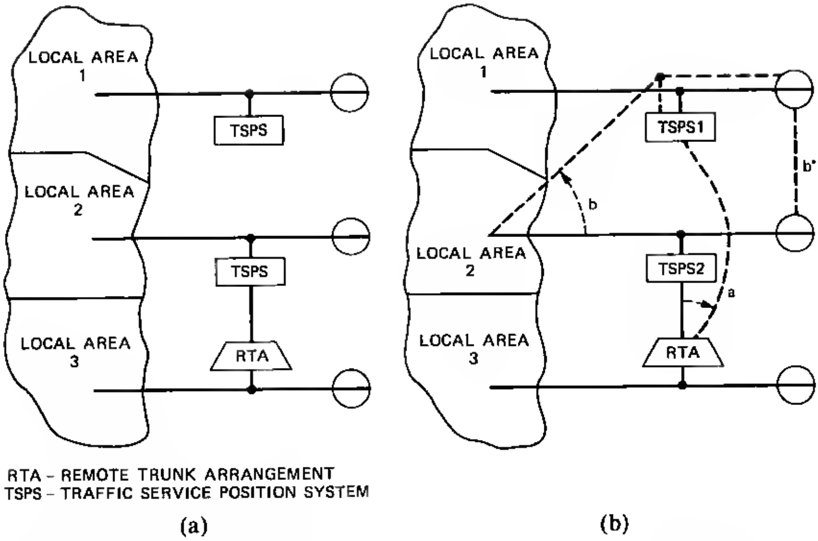


Fig. 7—(a) Relationship of local offices and toll switches to TSPS/RTA's—the correspondence is one to one. (b) Effect on network of user-specified traffic moves during a Node Exhaust run.

- Toll-connect mileage and facility information, including the percentage of 2-wire and 4-wire bridges.
- Community of interest and intertoll mileage/facility information.

4.5 Economic evaluation and translator programs

Economic evaluation of the alternatives is performed by TASP, which has already been mentioned. Telephone company planners are very familiar with this program, which has been in use for years. TASP requires a considerable amount of input, even for studies involving only a few switches. A fourth program, the Translator program, transcribes the output of the three preceding programs into TASP format without user intervention. The PSS and TSPS/RTA Network programs write files in a compact language which is translated into TASP language by the Translator program.

V. RUNNING THE PROGRAMS

The generation and economic evaluation of a complete alternative with OSTNPS involves the following steps to be taken by the user:

- Run the Node Exhaust program.
- For the above Node Exhaust program alternative, run one or a few appropriate PSS alternatives.
- Run each of these PSS alternative through TASP and choose the best.

* Run the Network program for the above Node Exhaust program alternative.
* Concatenate the best PSS alternative with the Network program alternative, and run this complete alternative through TASP.

This TASP output constitutes the economic evaluation of this complete alternative, to be compared with others.

VI. CONCLUSION

OSTNPS is an operator services long-range planning tool. It allows the user to analyze in a short time different strategies of operator services network evolution. For high-growth areas, OSTNPS evaluates various types of load-balancing alternatives versus purchase of new equipment. For low-growth areas with underutilized nodes, OSTNPS helps the user determine whether or not to retire those nodes. For both of these cases, OSTNPS allows the user to easily incorporate the conversion to TSPS No. 1B into the planning process. OSTNPS is not an optimizer, but instead lets users generate and evaluate their own alternatives.

VII. ACKNOWLEDGMENTS

The authors wish to thank R. G. Crafton of AT&T, who contributed in innumerable ways, and the operator services planning organizations of Mountain Bell Telephone and Bell of Indiana, who helped us during program development.

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